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Distribution Logistics Course

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OTREC

FINAL REPORT

OREGON
TRANSPORTATION
RESEARCH AND
EDUCATION CONSORTIUM

Distribution Logistics Course

OTREC-ED-09-02
August 2009

A National University Transportation Center sponsored by the U.S. Department
of Transportation's Research and Innovative Technology Administration

DISTRIBUTION LOGISTICS COURSE

Final Report

OTREC-ED-09-02

by

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Portland State University

for

Oregon Transportation Research
and Education Consortium (OTREC)
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16. Abstract Commercial vehicle movements associated with the delivery of goods and services are currently experiencing a number of challenging problems. Carriers and fleet operations face congestion, a growing number of tolls, increasing service level demands, and in some cases opposition due to the externalities caused by freight traffic in urban areas. This course provided a greater understanding of the complex issues surrounding urban freight and logistics and it was relevant to graduate students in civil engineering, urban planning, and business programs.					
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EXECUTIVE SUMMARY

The subject of Distribution Logistics was offered to upper-division undergraduate students and graduate students at Portland State University (PSU) in 2007 and 2008 under the umbrella of a Freight and Logistics course. The course has largely been praised both in terms of filling a course gap and being well received by students, but also as a leveraging tool for fueling additional research opportunities for both students and faculty.

The course was attended by over 20 students. The students came from diverse backgrounds and majors including civil engineering, urban planning, and business administration. Guest speakers provided the students with real-world examples of the complex issues that permeate the interactions between private enterprise logistics needs, public infrastructure, and society.

Student comments demonstrated that the course generated interest in freight transportation and improved appreciation of the complexities of developing freight and logistics systems. The project stimulated the submission of successful research proposals, strengthened relationships with transportation agencies, encouraged the development of new transportation courses, and made available a new topic in transportation teaching for students in the Oregon University System.

1. BACKGROUND AND OBJECTIVES

This course provided a broad and multidisciplinary approach to managing distribution logistics issues in urban areas. The efficient, timely, and reliable movement of freight is a critical responsibility of the transportation system and strategically important to the U.S. economy. The sheer amount of freight moved in 2005 by all transportation modes in the United States alone is staggering – some 10 trillion dollars of freight and over 16 billion tons of raw materials and finished products.

Efficient supply chains for truck, rail, waterway, port, and ocean links require strong and reliable freight transport systems. Freight transportation supports the activities of our society and economy that are essential to our lives. Today, Americans purchase billions of dollars worth of goods over the Internet for home delivery, routinely sent using next-day express packages. They also expect globally produced fresh fruits, flowers, and vegetables to be available year round. These shipments move over an extensive freight transportation system comprising millions of vehicles and thousands of miles of road, track, and pipeline infrastructure — all supported by sophisticated information technology and operated, managed, and maintained by a large labor force. These are astounding and vital concepts for students in transportation engineering and planning to understand.

The long-term goal of this course was to provide a greater understanding of the complex issues surrounding urban freight and logistics that would be relevant to graduate students in civil engineering, urban planning, and business programs. Previously, there was no course at PSU that tackled the specific issues of distribution logistics in urban areas. The previous course in freight transportation was an introductory course that focused mostly on the study of different transportation modes at a regional/national level. Finally, the topics emphasized in this course address several of OTREC's key themes and priority research areas such as integration of land use and transportation, transportation and mobility, and the impacts of congestion on businesses and the economy.

2. PROJECT DESCRIPTION

This project developed a course in distribution logistics and urban freight, designed to appeal to students from different fields of study.

The course presented a multidisciplinary approach to the study of urban logistics, its stakeholders, and the environment. This is significant because freight transportation is heterogeneous in nature – meaning various commodities are moved by various modes and carriers over numerous routes – and is almost exclusively the domain of the private sector. The public infrastructure, however, supports much of the freight system. This heterogeneity and the level of private-sector involvement present unique challenges for transportation professionals. A working knowledge of supply chain/logistics and the freight transportation system is essential to develop long-range transportation plans and projects to improve and enhance the freight system in a particular region, as well as to minimize negative impacts on the environment, communities, and the economy.

This course was designed with the following objectives for student learning:

1. Understand the fundamental concepts of supply chain management and their relationship to freight transportation system performance.
2. Comprehend the opportunities and challenges associated with economic globalization and the intermodal and multimodal nature of present and future transportation systems.
3. Understand the availability of data sources and models for use in planning, research, and design of freight and logistics systems.
4. Understand the challenges of logistics/distribution in congested urban areas.
5. Learn skills necessary to be integral players in public/private transportation/logistics planning, design, and operation teams.
6. Perform individual research with proper citation of academic sources, and communicate results to colleagues and instructors.

The course syllabus and schedule (Appendix A and B) was designed to touch on a variety of issues integral to students' comprehension of the urban and regional freight system. This includes a better understanding of carrier and commercial vehicle operations; shippers' perspectives and behaviors as a function of supply chain and commodity types; and the public sector's perspective, freight planning models and frameworks.

The operation of commercial vehicles as a derived demand was approached using location and inventory models. Carriers' perspectives were studied through routing and distribution models. The behavior of shippers and carriers was explained using economic and operational research models. The standpoint of public agencies was discussed with regards to state and metropolitan policy goals. Commercial vehicle tours and logistics issues have been largely ignored in traditional four-stage transportation modeling and in most urban freight models. The course introduced state-of-the-art urban freight modeling approaches and highlighted desired features, shortcomings, and opportunities for future research.

Case studies were analyzed to familiarize students with the conflicting priorities and goals among modes, operators, communities, private enterprises, and regulatory agencies.

3. OUTCOME AND RESULTS

The course was based on lectures, readings, class discussion, student presentations, guest speakers, and a final research report. Guest lecturers brought real-world perspectives to the class and helped students understand the complex interactions between business logistics needs, public infrastructure, externalities¹, and social impacts of freight movements.

Students selected topics for their final reports (see Appendix C for a sample of the diversity of interests and topics chosen). A list including almost 1,000 freight and supply chain journal and publication references was developed to guide students in their research reports (Appendix D). Guest speaker presentations and course material are available on the course Web site: <http://wiki.cecs.pdx.edu/bin/view/Main/CE453-553>.

Selected titles of term papers submitted by undergraduate and graduate students include:

- The Impact of Increasing Demand for Sustainable Food Products and Practices on Grocery Supply Chains;
- The Effects of Terminal Costs on Supply Chains with LTL Shipping: observed causes, effects and mathematical analysis;
- Effects of the Trucking Hours of Service Changes;
- A Comparative Analysis between the U.S.-Mexico and U.S.-Canada Borders;
- Greenhouse Gases and the Food Supply Chain: Thinking Beyond Transportation Impacts;
- Analyzing the difference between Retail and E-commerce Transportation in Long-tail Used Book Sales;
- Value Analysis of Truck-only Lanes in Metropolitan Areas;
- Carbon Emissions in Freight Transport: Evaluation and Reduction Tactics;
- Oregon's Axle-Weight-mile Tax: a comparative analysis;
- Intelligent Freight Technologies;
- The Critical Role of Third-Party Logistics (3PL) Services in the Supply Chain Management and Logistics Industry;
- Freight Truck Damage Study;
- Loading & Unloading Freight Zones in Portland Urban Areas;
- The Environmental Effects of Freight Transportation;
- Impacts of Environmental Restrictions on Supply Chain Decisions; and
- Freight Transportation Research Project: Where does it come from? How does it get here? Our Nation's Food Supply

The course attracted 14 undergraduate and 12 graduate students. Student comments revealed that the course materials sparked an interest in freight transportation issues and increased awareness of the complexities of designing a freight and logistics system. Student feedback has been included in Appendix E.

¹ A cost (benefit) is considered external when it is not paid (enjoyed) by those who generate it.

The course spurred the production of reports and white papers. In addition, class presentations and discussions stimulated the submission of an array of successful (i.e., awarded and funded) research proposals by the PI in the freight and logistics fields. Some of these research projects are: Performance of Freight Corridors in the Pacific Northwest; Analysis of Travel Time Reliability for Freight Corridors; Quantification of the Impact of Congestion on LTL Industry Costs and Performance in the Portland Metropolitan Region; Environmental and Public Health Impacts of Traffic Flows and Traffic Management Policies in Urban Areas; and Future Flooding Impacts on Transportation Infrastructure and Traffic Patterns Resulting from Climate Change. These research proposals have employed a growing number of graduate students and have strengthened the symbiosis between teaching and research activities.

The course strengthened the transportation programs offered in the Oregon university system as this is the only course offered that integrates supply chain, freight, and logistics concepts. In addition, ties and links to the Port of Portland and the Oregon Department of Transportation were strengthened by the presence of guest lecturers and discussion of research opportunities in freight and logistics.

The course syllabus, selected references, final report abstracts, and student feedback can be found in this report's Appendixes. According to the student feedback, the course spurred an interest in freight transportation and increased awareness in the complexities of designing and planning freight infrastructure.

4. FUTURE ACTIVITIES

The success of this course in terms of student feedback and research outcomes has lead the PI to plan an additional course in the freight, logistics, and sustainability area. The future course will focus on international trade and freight transportation issues. The growth of international trade and the globalization of production have considerably increased the significance of international logistics. Trade growth has resulted in a rapid increase of shipping value and tonnage led by containerized trade. In turn, containers and intermodal transportation have improved the efficiency of global supply chains, allowing for a faster, more efficient and more economical flow of cargo.

This future course will be designed to familiarize students with the special characteristics of the international freight industry in general and the container shipping industry in particular. The course includes topics such as international trade and logistics; maritime and air transportation logistics in the supply chain context; port/airport requirements; fleet management; routing and scheduling; intermodal transportation; security; and technology. In addition, the course will familiarize students with energy consumption and emissions that originate from international trade. Accounting and modeling approaches that include life-cycle cost analysis will be introduced. The appropriateness of simplistic energy and emission models (e.g., food-miles concepts) also will be discussed.

APPENDIX A: COURSE SYLLABUS

Course Statement

The efficient, timely, and reliable movement of freight is a critical responsibility of the transportation system and strategically important to the U.S. economy. The sheer amount of freight moved in 2005 by all transportation modes in the United States alone is staggering – some 10 trillion dollars of freight and over 16 billion tons of raw materials and finished products.

Efficient supply chains with truck, rail, waterway, port, and ocean links require strong and reliable freight transport systems. Freight transportation supports the activities of our society and economy that are essential to our lives. Today, Americans purchase billions of dollars worth of goods over the Internet for home delivery, routinely send next-day express packages, and buy fresh fruits, flowers, and vegetables produced globally. These shipments move over an extensive freight transportation system comprising millions of vehicles and millions of miles of road, track, and pipeline - all supported by sophisticated information technology and operated, managed, and maintained by a large labor force.

Freight transportation is heterogeneous in nature – meaning various commodities are moved by various modes and carriers over numerous routes – and is almost exclusively the domain of the private sector. The public infrastructure, however, supports much of the freight system. This heterogeneity and private-sector involvement presents unique challenges for transportation professionals. A working knowledge of supply chain/logistics and the freight transportation system is essential to develop long-range transportation plans and projects to improve and enhance the freight system in a particular region, as well as to minimize negative impacts on the environment, communities, and the economy.

Course Objectives – Students must demonstrate the ability to:

1. Understand the fundamental concepts of supply chain management and their relation to freight transportation system performance.
2. Comprehend the opportunities and challenges associated with economic globalization and the intermodal and multimodal nature of present and future transportation systems.
3. Understand the availability of data sources and models for use in planning, research, and design of freight and logistics systems.
4. Understand the challenges of logistics/distribution in congested urban areas.
5. Be prepared to be integral players in public/private transportation/logistics planning, design, and operation teams.
6. Perform individual research with proper citation of academic sources, and communicate results to colleagues and instructors.

Course Evaluation

The course is open to both graduate and undergraduate students and there will be different expectations for each group. Graduate students are held to higher standards in grading and may be required to do more work on problem sets and exams. If I have made a mistake in recording your grade, please send me an email with the subject heading “grade correction” notifying me of my error. I will ask you to show me the corrected assignment. For this reason, save all of your returned work! The course grade (A-F) will be determined with the following weight for class assignments:

Assignments:	30%
Research Paper:	40%
Final Exam:	25%
Participation	5%

A grade of incomplete (“I”) is granted by the instructor *only* with prior approval and consent. Criteria are outlined in the PSU Bulletin. Note that for civil engineering undergraduates, the CEE Department requires that junior and senior engineering courses must be completed with a minimum grade of C-, and a student’s cumulative PSU GPA must be 2.25 or higher to graduate from the BSCE program.

Expectations of the Student

Professionalism

All assignments and class participation should be conducted in a professional manner. Attention to detail on class assignments and communication is important, is part of the learning experience and is included as part of student evaluations.

Attendance

Attendance is strongly suggested. We will do activities in class that will help in your learning of the material that can not be duplicated outside of the classroom. If you are going to miss a class, I suggest that you email your reason to me beforehand. If you are on the border for a grade, I will consider attendance in making my determination.

Late Work

Late work is NOT accepted. The due date for each assignment is clearly indicated and the work must be turned in at the start of class unless indicated otherwise. Exceptions can only be granted in the most extenuating circumstances.

Description of Assignments

Problem Sets (30 % of final grade)

Problem sets are assigned during the class session and are due the following week at the start of class. Your name, problem set number, and date should appear on the header of each page. Clearly restate the problem and provide your answer. I would greatly appreciate that you staple multiple page assignments.

Exam (25% of final grade)

In this class, there will be one comprehensive final exam worth 25% of your grade.

Participation (5% of final grade)

Participation is especially important during presentations (guest lecturers, student presentations, etc.) and during discussions of reading assignments.

Freight Transportation Research Project (40% of final grade)

A professional paper based on a relevant topic in freight transportation and logistics, which is of interest to the student, is required as an integral part of this course. The topic will be selected in close consultation with the instructors. The student is required to perform individual library and literature-based research (Note: Research is much more than just typing in a word at Google.com.) - If this is your first paper and/or presentation for a graduate class, you are particularly encouraged to seek individual guidance from the instructor. The paper will be developed as follows:

- | | |
|--------------------|--------------------------------------|
| ▪ January 8, 2007 | Discussion of possible paper topics. |
| ▪ January 31, 2007 | Paper proposal due. |
| ▪ March 20, 2007 | Final paper due. |

Paper Proposal (15% of project grade)

Select a topic that is of interest to you and reasonable in scope - not too narrow and not too broad. This is not an easy task so please do preliminary research. Note that this is 15% of the paper grade, which is 40% of your final grade. I can't stress enough how a well-thought-out proposal will make your life easier! In addition, be sure that there is plenty of information relating to your topic in easily obtainable sources. In selecting your topic, you should think beyond presenting simply history or a literature survey; you should think of what new ideas and innovative solutions you can add to a particular topic. Papers that use actual data for analysis of an issue will receive higher evaluations. The paper should be written in your own words, with careful attention to proper citation of sources. A discussion of possible topics will be held. In addition to the required library research, it may be helpful to initially explore some Web sites, especially:

- | | |
|----------------------------|---|
| ▪ FHWA Operations, Freight | http://www.ops.fhwa.dot.gov/freight/ |
| ▪ FHWA, Freight Planning | http://www.fhwa.dot.gov/freightplanning/index.htm |
| ▪ TRB Special Report | http://trb.org/publications/sr/sr276.pdf |
| ▪ Oregon DOT | http://www.oregon.gov/ODOT/TD/FREIGHT/ |
| ▪ CSCPM | http://cscmp.org/ |

See if you can do some preliminary scanning and find a subject that interests and maybe even excites you. I have listed several possible topic ideas for your consideration (suggestions only, you can choose other topics):

- Technology and freight/supply chains (RFID)
- Driving hour change impact on safety and trucking efficiency
- Environmental impacts
- Models (routing, distribution, commodity flows)

- Current practices in statewide freight transportation models (literature review)
- Economic impact of system interruptions (weather, terrorism, natural disasters, bridge load restrictions)
- Security issues in freight transportation
- Data issues for freight transportation
- Truck size and weight issues (ITS lab has access to weigh-in-motion data and classification data)
- Performance measures for freight transportation planning
- Mode choice models and issues
- Routing models and analysis (UPS, FedEx)
- Portland truck loading/unloading zones in urban areas
- A comparison of analysis methods for converting tons of freight flow into vehicle units
- Value of time for commercial vehicles
- Container barging trends on the Columbia River
- Third-party logistics
- Oregon's weight-mile tax
- Overweight enforcement of motor carriers (optimum deployment of stations or enforcement officers)
- Separated roadways for trucks
- Forecasting freight demand, input-output models
- Assessment of freight emphasis in DOT organizational structures

At the minimum, your proposal should include the following:

- The title of your paper.
- CLEAR evidence of preliminary library and literature research. This should include a list of library references (minimum of 10 relevant journal articles or technical reports). These should be summarized in your research proposal.
- Specific objectives in bullet format (where you're going).
- Preliminary outline of the paper in Table of Contents format (how you're going to get there).

COMMON ISSUES/PROBLEMS WITH PROPOSALS: (a) references are inadequate (number or subject), (b) lack of balance between industry and academic references, (c) outline does not relate at all to supply chains structure/types, and (d) too broad and vague. Sometimes projects are too ambitious or students do not realize that private-sector data collection may be difficult to obtain.

Research Paper (70% of the paper grade)

You will be evaluated on your paper as follows:

- Introduction/Background - 10 %
- Objectives - 10 %
- Body and Quality of Research Tools Used - 40 %
- Conclusions/Recommendations/Perspective - 20 %
- Language/Style - 10%
- Overall Impression - 10%

Please follow the Transportation Research Board (TRB) procedures for preparing your manuscript: <http://www.trb.org/Guidelines/Authors.pdf>

Minimum requirements for the paper are:

- Paper should consist of approximately 15 pages of double-spaced text using 12-point clearly legible type on one side of letter-sized paper (consult the lecturer if you need to change this limit).
- Top, bottom, left and right margins should all be one inch.
- All exhibits, tables, figures, charts and appendices should be labeled and sources cited. This will not count towards the suggested 15-page length.
- Number the pages in the upper right corner.
- Include a title page, abstract, body of paper, acknowledgments and list of specific references cited in the text.
- Please staple the paper in the upper left hand corner and use no special binding.
- Avoid jargon, acronyms, and use of personal pronouns in your paper.
- Each student must write an individual paper.
- The reference list shall include only those references cited in the text; number them in the reference list in the order they are first cited in the text.
- Denote a reference at the appropriate place in the text by an underlined or italic arabic numeral in parentheses (e.g., (2)).
- Do not repeat a reference in the list and do not use *ibid.*, *idem*, *op. cit.*, or *loc. cit.* If a reference is cited more than one time in the text, repeat the number first assigned to the reference.
- Do not use footnotes to the text. Incorporate such notes within the text.

Research Presentation (15% of the paper grade)

- Attendance (1/2 of presentation grade)
 - Please attend all paper presentations. This should be looked upon as an opportunity to gain experience making a professional presentation in a supportive environment among your peers.
- Delivery (1/2 of presentation grade)
 - The primary contributors to an effective presentation are (a) technical content, (b) visual aids, and (c) skills of the speaker. Remember that a presentation may (should) differ from the printed paper and that the presentation gives the author an opportunity to discuss and emphasize highlights of the work, which may not be possible to do in the printed version. It is recommended that you think towards structuring your presentation as follows:
 - Title
 - Objectives
 - Outline of Presentation
 - Methodology
 - Body
 - Summary
 - Conclusion
 - Perspectives

Do not read the paper or presentation. Practice to become completely familiar with your presentation so that you can speak from memory or notes. Concentrate on your delivery. Speak clearly and at a pace somewhat slower than normal conversation. Avoid a monotone. Can you be heard throughout the room, and are you facing your audience instead of looking at the visual aids? Your presentation will be limited in time (to be determined). Most people are surprised when their time is up! It is very helpful if you practice your talk beforehand, keeping track of elapsed time. Recognize that actual presentations usually take longer than rehearsals. Help your audience by not exceeding your allotted speaking time.

Visual aids are always effective tools for communicating your ideas quickly, and therefore are recommended. An overhead projector will be available. Do not consider using the white/chalk board as a substitute for visual aids. Please do not use all-text visuals that convey no additional information to the audience. A maximum of one or two visuals should be used per minute of presentation. The instructor will be happy to assist you in the development of visual aids.

Research and Learning Opportunities

Transportation is a growing and exciting research area at PSU. I invite you to review the research in the Intelligent Transportation Systems Laboratory (www.its.pdx.edu/). Also, every Friday during the semester a Transportation Seminar is presented. All are welcome. The schedule is available at www.cts.pdx.edu.

Library and Literature Research

Required Texts and Other Materials

Supply Chain Management, by Chopra & Meindl (important for the first part of the course)
The Geography of Transportation Systems, by Rodrigue, Comtois, & Slack
Journal papers and reports as indicated in class

An Appendix with 198 selected references has been prepared to facilitate your initial search and to provide topic ideas. With the advent of the Internet it is very tempting to think that all necessary resources for a term project will be available in full text after typing in a few words at Google.com. This is not the case. You will often need to go to the library, use real library search tools, and access real books and articles contained in refereed/archival journals.

Be sure to make use of the Vikat library catalog. Go to the PSU library home page at www.lib.pdx.edu/. Also available on the library home page are Full Text Electronic Journals: www.lib.pdx.edu/~bvws/bytitle.html, and a list of on-line Databases: www.lib.pdx.edu/resources/databases/databases.html. Also, try EI Compendex (www.engineeringvillage2.org/) and Lexis-Nexis. Note that access to these databases is free for PSU students, but you must be using a computer on campus or via a dial-in service. See http://www.lib.pdx.edu/resources/databases/EZ_proxy.html for instructions on how to gain off-campus access using a proxy server.

*Drs Bertini and Monsere contributed to this syllabus

APPENDIX B: COURSE SCHEDULE

#	D	Date	Topic	Week	Assignment Given- Due	Reading
1	T	8-Jan	Introduction, Supply Chains	1		Chapter 1 – C&M
2	R	10-Jan	Supply Chains Fit and Scope			Chapter 2-3 C&M
3	T	15-Jan	Supply Chains Performance	2		
4	R	17-Jan	Inventory in the Supply Chain			Chapter 10-11 C&M
5	T	22-Jan	Inventory in the Supply Chain	3	Given (1)	Chapter 10-11 C&M
6	R	24-Jan	Distribution Networks			Chapter 4 C&M
7	T	29-Jan	Network Design	4		Chapter 4-5 C&M
8	R	31-Jan	Network Design - Intro to Trucking		Given (2)	Chapter 13 C&M
9 - Transportation Seminar Feb 1 st at 12 - Room 204 Urban Center						
10	T	5-Feb	Guest Lecture – Chris Monsere	5	Due (1)	
11	R	7-Feb	Assignment 1			
12	T	12-Feb	Guest Lecture – Scott Drum	6		
13	R	14-Feb	Assignment 2		Due (2)	
14	T	19-Feb	Product Availability - Mode Choice	7	Given (3)	Chapter 12 & 14
15	R	21-Feb	Distribution in Urban Areas Congestion Costs			See Course Webpage
16	T	26-Feb	Rail Capacity Rail Intermodal	8		
17	R	28-Feb	Guest Lecturer – Barry Horowitz			
18	T	4-Mar	Sustainability, Vehicle Emissions	9	Due (3)	See Course Webpage
19	R	6-Mar	Freight Planning and Financing			
20	T	11-Mar	Research Paper Presentations	10		
21	R	13-Mar	Research Paper Presentations			
FINAL EXAM Thurs., Mar. 20, 1015-1205 Final Paper DUE						

APPENDIX C: SELECTED RESEARCH REPORTS

The Impact of Increasing Demand for Sustainable Food Products and Practices on Grocery Supply Chains

This paper looks at recent actions taken by two large grocery retailers, Wal-Mart Stores, Inc. and Whole Foods Market, in response to increased demand for sustainable food products.

“Sustainable” in this context is mainly considered to be locally grown and organic fruits, vegetables, dairy, and meat products. The goal of this paper is to outline the strategies of both entities to accommodate this increased demand and consider the effect, if any, that it might have on their supply chains.

The Effects of Terminal Costs on Supply Chains with LTL Shipping: observed causes, effects and mathematical analysis

Traffic congestion and delay are becoming increasingly significant problems for the U.S. freight trucking industry. While freight transportation has continued to grow steadily, the capital spending and construction of freeways and major highways has remained mostly stagnant since the mid-1970s when the interstate freeway system reached completion. Much attention has thus been paid to methods of most efficiently using the road space available, particularly in dense urban areas, with lane tolling, freeway ramp metering and other measures being utilized. Major freight companies also pay close attention to delivery vehicle routing in congested areas to maximize shipments and minimize dwelling time and stops.

The costs of delays to freight vehicles are often caused by another component besides traffic congestion-related costs. Substantial costs are often incurred at the starting and stopping locations of a given route and are called terminal costs. Terminal costs are influenced primarily by factors that either directly increase delay times at terminal points, or factors that increase the relative time and cost of delay to a company, which become amplified when delay is difficult to predict or variable along a freight tour. Predicting these delays is important for truck freight to minimize costs from many externalities.

This paper contains both a qualitative and quantitative analysis of factors that affect efficiency from within the supply chain and from external causes occurring at terminal locations, as well as the costs incurred. Various effects in the areas of government policies, market structures and operations management are analyzed for the impacts on supply chain costs in direct and indirect ways. A more rigorous mathematical analysis is provided in the final section on particular issues where cost-sensitivity is high.

Effects of the Trucking Hours of Service Changes

In 2007, more than 4,500 people were killed in crashes involving large trucks, while another 76,000 people were injured. The truckers’ hours of service (HOS) have been named as one of the main contributors to these crashes. Research suggests that the risk for crashes increases dramatically for drivers exceeding an eight-hour work day. The Federal Motor Carrier Safety

Administration (FMCSA), a division of the U.S. Department of Transportation (USDOT), is in charge of such regulation implementation and execution (4)(5).

A solution to change driver hours will statistically reduce the risks of truck crashes. However, the effects of these changes extend beyond the safety aspects. The economic impacts affect all modes of transportation and trickle down to the consumer. Studies done during the 2004 HOS changes revealed a possible \$611 million increase in operating costs for truckload (TL) carriers and a need to hire over 84,000 additional drivers to continue operating services and complying with new policies.

In addition to this dilemma, there are other considerations. First, increased competition from foreign countries such as Mexico can provide cheaper labor. This option may be the only financial possibility for many companies. Then, there is also a problem with conflicting interests in the trucking companies related to how they pay their drivers. Swift Transportation is a major American trucking company that pays their drivers based on how many miles they drive. They also offer an extra bonus if truckers drive more than 9,500 miles in one month (15). If drivers can increase their pay by driving more, then placing more restrictions on HOS will upset truckers trying to earn a larger paycheck.

This paper analyzes the effects on the trucking industry and the supply chain, and the costs to the consumer. In addition, the paper examines the industry culture of some trucking companies and how their structure may interfere with the effort to minimize trucker fatigue. The paper provides a brief overview of what other industrialized nations are doing in regards to trucker driving hours. And finally, the cost of these driving limitations have made some trucking companies look south to Mexico for cheaper drivers. The Bush administration proposed increasing the zone in which Mexican drivers can enter the United States. The paper also suggests some alternative solutions or enhancements to what is already in effect, based on the research conducted.

A Comparative Analysis between the U.S.-Mexico and U.S.-Canada Borders

Increased trade between the U.S., Mexico and Canada, along with recent security measures at border crossings, have created delays for the trucking industry and consequently have had an impact on the supply chain. This paper investigates the differences in border control policy at the U.S.-Mexico and U.S.-Canada borders that have led to increase in delays. Several case studies are presented in which the issue of border-crossing delay is investigated and its implications on the supply chain are discussed. Current methods in mitigating delay are presented from policy, planning, and design perspectives. Discussion of current issues and recommendations for future studies and efforts are provided.

Does Induced Travel Affect Location Choice for Commercial/Industrial Development?

The effects of induced travel are used to determine whether or not it is necessary to build new roads, expand existing ones, or not build at all. The addition of lane miles to an urban area with the intent to improve traffic flow, or expand the current urban area, can have a varying degree of impact on commercial/industrial travel based on the choices of which roads to improve and how much improvement should be made. If there are significant increases to operating speeds and to access, the likelihood of new construction increases as does the amount of traffic.

While induced travel is an important consideration when determining future increases in VMT, there are several other factors that must be taken into consideration before deciding to build new roads or to begin new construction where a proposed improvement is going to take place.

Greenhouse Gases and the Food Supply Chain: Thinking Beyond Transportation Impacts

Like other goods, food now comes from all over the world through complex supply chains. Transportation-related energy and greenhouse gas emissions have been targeted as key culprits of climate change. This paper examines the extent of transportation's contribution to the overall greenhouse gas emissions associated with food. It reviews literature on how to measure the greenhouse gas impacts of food and opportunities for reducing these impacts. It also analyzes the lifecycle CO₂ emissions associated with four food products: Coffee/tea, bread, butter, and beer. Results show that transportation plays a relatively small role in the total greenhouse gas impact of food. The results have implications for policies to target greenhouse gas reductions from food systems.

Analyzing the difference between Retail and E-commerce Transportation in Long-tail Used Book Sales

The difference between retail and e-commerce transportation is becoming increasingly more important as more and more goods and services are becoming available online. This paper uses Powell's Books as a case study to better understand the differences between and implications of these two methods of sale. Specific attention is paid to emissions caused by different methods of transportation. A general model is proposed, and levers are identified that could potentially influence companies faced with the choice of traditional retail vs. e-commerce.

Value Analysis of Truck-only Lanes in Metropolitan Areas

Truck travel in the United States has more than doubled since 1970 as measured in vehicle-miles traveled (VMT), whereas the population has increased by only 33 percent. Growth in the number of trucks is expected to continue, bringing with it a commensurate increase in the number and severity of vehicle crashes. Nationwide statistics indicate that fatal crash rates are higher when trucks are involved. The growing number of trucks using urban freeways has caused transportation officials to seek innovative strategies for providing truck mobility in ways that do not add to freeway congestion, as well as federal or state funding to pursue such strategies. The primary existing special truck treatments, such as bypass facilities, dual facilities and different speed limits, are implemented in some areas, but the exclusive lane or exclusive facility for trucks are rare. One of the strategies being considered in several locations is truck-only lanes, which also make roadways safer for passenger cars.

Carbon Emissions in Freight Transport: Evaluation and Reduction Tactics

The transportation sector contributes a substantial amount to worldwide greenhouse gas emissions. The subsector of freight transport is imperative to the success of the global economy, but also plays a role in the ever diversifying issue of greenhouse gas emissions. With more and more evidence to suggest that these emissions are causing harm to the planet and its inhabitants, steps are being taken on many levels to help curb these emissions, both in and out of the freight transport sector. Technologies are being designed and applied to all modes of goods movement

vehicles in the form of equipment and fuel modification. Also, federal, state, and local authorities, along with a variety of other groups and organizations, are all doing their part in the emissions reduction battle. In addition, emissions play their role in supply chain costs and schematics, forcing companies to take a closer look at their emissions and the effects on their supply chains and the environment.

Oregon's Axle-Weight-mile Tax: a comparative analysis

This paper will make a comparative analysis of Oregon's axle-weight-mile tax for commercial carriers and other taxation methods in regards to their ability to properly apportion costs and influence the operational decisions made by commercial carriers. One of the critical issues facing transportation planners and engineers in the near future is how to finance and maintain the aging interstate highway infrastructure. A major trend in transportation literature has been towards the use of taxation systems that attempt to more fully capture and properly apportion all the associated costs of the transportation system. For passenger vehicles the areas of concern are primarily congestion and fuel consumption/emissions, while for freight the focus has been on infrastructure wear. An analysis of the impacts of Oregon's axle-weight-mile tax can provide some insight into how the realities of cost allocation stack up against the expected outcomes.

Intelligent Freight Technologies

Intelligent freight technologies use information technologies and communications to improve the freight network and facilitate profitable supply chain and logistics. They are deployed in several areas including asset tracking, on-board status monitoring, gateway facilitation, freight status information, and network status information. The freight system has the potential to improve efficiency and productivity, increase international connectivity, and enhance security and safety by utilizing these technologies. However, there are implementation barriers hampering widespread adoption. Once implemented, the private sector, public sector and the freight network as a whole will benefit from the intelligent freight technologies.

The Critical Role of Third-Party Logistics (3PL) Services in the Supply Chain Management and Logistics Industry

Information technology, inventory management, reverse logistics, international freight services, packing and shipping, mode of transport, and establishing best suitable warehouse operations are the major functions of logistics and supply chain management. A significant amount of financial investment is required to invest in each of these functions in order to operate the business smoothly and efficiently. Third-Party Logistics (3PL) specializes in logistics and supply chain management; thus, 3PL has already acquired and owned all of these necessary tools and facilities in order to support the entire logistics operations. For a newly established firm, allocating money in the areas that are important and necessary for expanding the business is the best option instead of investing the capital assets such as acquiring delivery vans and either purchasing or renting storage. Thus, a firm can benefit by hiring a 3PL provider as a short-term contract in order to build up and expand business.

Freight Truck Damage Study

This report analyzes the damage caused by freight trucks to United States roadways and evaluates the benefits and costs of subsidizing freight truck transportation through public money, which is mostly supplied by passenger car drivers. This study contains independent estimates of

the actual percentage of pavement damage caused by freight trucks, based on a combination of AASHTO (American Association of State Highway Transportation Officials) flexible- and rigid-pavement design procedures and statistics gathered by the Bureau of Transportation Statistics and other government agencies. Other estimates are referenced in the report, but all estimates agree that freight trucks cause a disproportionate amount of damage to pavement relative to the amount of money that trucking companies pay in fuel and other taxes. After an explanation of how this study's own estimates were obtained, the report discusses related issues. Which parties pay for this damage, what kind of companies benefit from the subsidization of the trucking industry's transportation network, and comparisons of the costs and benefits that freight trucks cause the U.S. economy are presented.

Loading & Unloading Freight Zones in Portland Urban Areas

Portland is becoming a more populated city and freight delivery is a major future concern. This paper provides a brief look at the importance, design, regulation and the types of vehicles that are using loading zones. It provides a brief background on what the City of Portland is currently doing to manage freight delivery. We can then take a look at what Portland is doing right as far as how it addresses loading zone issues. An observational field study and literature review take a look at some of the major issues and problems downtown Portland faces. Knowing the problems will then make it easier to analyze the issues and come up with a few suggestions that could improve delivering freight in downtown Portland.

The Environmental Effects of Freight Transportation

Transportation contributes to global climate change through emissions of carbon dioxide, methane and other hydrocarbons, nitrous oxide (N₂O), and water vapor discharged mainly by aircraft. This paper discusses three major threats that the environment faces today: trucking, shipping and aircraft transportation.

Impacts of Environmental Restrictions on Supply Chain Decisions

The purpose of this paper is to explore the changes, both present and in the near future, in environmental regulations as they apply to the freight industry. Recent developments in truck emission restrictions have made marked changes in the cost of doing business in that industry. In such an industry, where profit margins are razor thin, any such added cost, particularly one that is universally applied to the industry, can't help but be passed on to the customers. In the case of freight movement, the customer is everyone. Freight movement is such a vital part of the United States economy that any interruption could be disastrous. Economic predictors indicate that there will continue to be steady, consistent, large growth in ton-miles in the freight industry, so it is unlikely that the increased cost will be absorbed by a decrease in freight movement.

This paper will look at how a freight planner might cope with these changes through possible modal shifts. The approach to that is to analyze available literature to attempt to quantify the financial costs associated with freight emissions regulations, and then analyze a sample mode choice problem to see just how these requirements might affect mode choice. This work is important because mode choice represents multi-million dollar decisions for many sectors of our economy, and because these restrictions are not theoretical but are in place now and are getting stricter. Also, one cannot seem to go a single day without hearing of the causes and effects of climate change, and the solution most often proposed for this is restrictions in carbon dioxide

emissions. It would benefit a freight logistician to understand this information and be able to apply it to decisions about how freight might be shipped.

Freight Transportation Research Project: Where does it come from? How does it get here? Our Nation's Food Supply

This project delves into the issue of food supply in the United States. It examines the food that is supplied from local producers and those that supply produce that is transported long distances to market. The supply chains that each food supplier uses and the modes of transportation each employs are described and explained. The impacts of each system have positive and negative benefits for communities, states and individual countries. These benefits include environmental, energy and economic factors. Social considerations also are discussed as part of this project.

APPENDIX D: REFERENCES

This course will familiarize future policy makers, academics, and practitioners with the complexities and challenges of urban freight and distribution issues within urban areas.

This course will spur the production of reports and white papers that will contribute to the understanding of freight issues in urban areas and its economic and environmental impacts. It is expected that the course will also generate preliminary research papers, research topics, and technology transfer proposals related to urban freight/logistics issues.

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APPENDIX E: STUDENT FEEDBACK

At the end of the term students submitted comments and suggestions. The course sparked an interest in freight and transportation issues and an increased awareness in the complexities of designing and planning freight infrastructure.

Comments

- I would have preferred less focus on supply chain math and more conceptual focus on more and the nuts and bolts of freight customs, etc. Overall great course.
- I like his teaching style. I think we should have more homework assignments since they are worth 30% of the grade. God Dr.
- Good class and teacher for class. Could be more organized and I thought the book was not very helpful.
- Homework: We only had 3 assignments worth 30% that 10% for each one. I think this needs to be more balanced. In class, more example problems.
- Good course. I really enjoyed the speakers and maybe more speakers would be great.
- The guest speakers were great, especially Mr. Horowitz. Overall, the course was great. The reading material from the book was at a faster pace than I prefer. I also would rather have a couple more homework assignments with a reduction in the research report.
- I really enjoyed this course. I would like to see more freight/logistics courses offered for engineering students. Dr. Figliozzi was helpful/available often.
- More and smaller homework assignments might help students do better overall. The homework problems selected took up large amounts of time (maybe too much for homework). The size of the final report should be smaller.
- Overall the class content was good. I really enjoyed the guest speakers; they gave a good perspective of the real world.
- The pace was too fast. Slower explanation of supply chain optimization concepts would help. There was a heavy workload compared to other classes. Reduce assignments; good integration of concepts with real- life events, topics, experience.
- I would suggest spending more time during class doing example problem- solving. Practice doing homework- like problems helps me a lot with understanding the work- flow of applying the knowledge and formulas.
- The course information was interesting and completely new to me.
- There should be more problem sets, just having a few large and complex problems made it difficult to relate concepts to each other. I didn't feel the project was particularly useful. Shorter topical papers and more problems would have been more useful.
- Overall, this course is good. Learning new things regarding to freight transportation and supply chain management is a new subject to me. If the class involves with more group project instead of doing individual presentation at the end of the quarter, I think the class will be more effective.

- This is the first time I've checked all boxes in the left column of section 2 (highest score), which is a very good thing for this course. This is a subject I am very interested in and Dr. Figliozi does a good job with it.
- This was an excellent course and has a great deal of value in the real world. I can very happy with this course and wish I could take
- more like it.
- Overall, the course was structured and presented well. One suggestion would be to assign small homework assignments directly related to the term paper (research, possible topic options, etc) in addition to the proposal to help guide preliminary research better.
- I enjoyed the up to date case studies. It made the subject seem more relevant. The pace of the class was good. I normally hate class discussion, but I actually enjoyed them this time. The small class size definitely helped. We needed a clearer overhead projector with better focus. The images were small and blurry.
- Professor was very encouraging.



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